STABILIZATION OF BLACK COTTON SOIL BY USING EGG SHELL POWDER AND GLASS POWDER

Dr. S. S. Saraf[1], Asana Y.Waghmare [2], Abhishek V.Ingle [3], Shripad S. mankar [4], Ajay M.Paithane [5]

[1]Associate Professor, P. R. Pote Patil College of Engineering & Management Amravati

[2]BE, Students, P. R. Pote Patil College of Engineering & Management Amravati

Abstract:

Soil Stabilization in a wide sense incorporates different methods utilized for altering the properties of soil to enhance its physical properties and engineering performance. the most well known application being in the road construction, airfield pavements and construction of high-rise buildings. Soil Stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils. In Maharashtra and particularly Vidarbha region top layers comprises of black cotton soils deposits are observed everywhere which is basically a clayey soil comprises of montmorillonite clay mineral as its major constituent. These soils are black in color thus the name black cotton soilsuggested, are found suitable for agricultural purposes but are problematic in nature to the civil engineering projects. The main aim of the study is to determine the performance improvement of black cotton soil by adding egg shell powder and glass powder as an additive. By varying percentage from 5%,10%,15% for egg shell powder and 2%,4%,6 for glass powder to compare the Unconfined Compressive Strength of black cotton soil with and without additive. The Study was conducted to investigate the effect of Egg Shell Powder and Glass Powder on Unconfined Compressive Strength of black cotton soil. Based on laboratory Study Egg shell powder and glass powder was found to be a good material to stabilize the black cotton soil. The use of egg shell powder in soil stabilization will reduce the disposal problems of egg shell as well as make the stabilization process economical and sustainable.

1. INTRODUCTION

Soil Stabilisation in a wide sense incorporates different methods utilized for altering the properties of soil to enhance its physical properties and engineering performance. Soil stabilisation is, no doubt utilized for arange of engineering tasks, the most well- known application being in the road construction and airfield pavements, where the primary goal is to build the soil quality or stability and to lessen the development cost by making best utilization of locally accessible materials. Soil Stabilisation is the process of improving the engineering properties of the soil and thus making it more stable. It is required when the soil available for construction is not suitable for the intended purpose. In its broadest senses, stabilization includes compaction, preconsolidation, drainage and many other such processes. However, the term stabilization is generally restricted to the processes which alter the soil material itself for improvement of its properties. A cementing material or a chemical is addedto a natural soil for the purpose of stabilization. Soil Stabilisation is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. Soil stabilisation is required

to increase the bearing capacity of foundation soils. However, the main use of stabilization is to improve the natural soils for the construction of highways and airfields. The principles of soil stabilisation are used for controlling the grading of soils and aggregates in the construction of bases and sub-bases of the highways and airfields. Soil Stabilisation is also used to make an area trafficable within a short period of time for military and other emergency purposes. Sometimes, soil stabilisation is used for city and suburban streets to make them more noise- absorbing. In Maharashtra and particularly Vidharbha region top layers comprises of black cotton soils deposits are observed everywhere which is basically a clayey soil comprises of montmorillonite clay mineral as its major constituent. These soils are black in color thus the name black cotton soil suggested, are found suitable for agricultural purposes but are problematic in nature to the civil engineering projects. Effect of volumetric changes in the form of swelling and shrinkage under the water influence pose numerous problems to the structures built on it such as cracks, undulations, uneven surfacing, settlement of different nature and magnitudes, etc. These soils are having less bearing capacity, less shearing resistance and are generally not suitable / ideal as a foundation soil for construction purposes.

2. LITERATURE REVIEW

Amu et al. (2005) had investigated the effects of egg shell powder (ESP) on the stabilizing potential of lime on an expansive soil. Based on different tests they found that ESP cannot replace lime, for stabilization of soil. by substituting eggshell powder in the place of lime, the resultant soil stabilization was increased when compared with the untreated soils. Here, 0.5%- 2.0% of eggshell powders were introduced to the overall soil weight in the formation of the mixture. Thus, 25% substitution of lime with eggshell powders offered increased tensile strengths, and thereby largely be applicable for the real-world purpose.

A.U. Ravishankar et.al (2006) conducted a comprehensive study of the Terra Zyme soil stabilizer product with abundantly available lateritic soil in Dakshina Kannada and Udupi districts does not satisfy the requirements (Liquid Limit ≤25% and Plasticity Index ≤6 %) to be used as a base course material in pavements.

According to Foroutan R., et al (2007) eggshell constitutes a 10-11% in a total weight of the egg. In Iraq, the yearly production of eggshell waste according to the above statistics is about 23,000 tons, considering that the weight of the shell is (10 packing density by effectively bounding the eggshell powder, increased total strength values are provided in the test results.

To assess different constructions that were carried out using black cotton soils, Abdulrahman S.M. et al (2007) carried out their research towards assessing the black cotton based soil based constructions in Iraq.

Anoop S.P. et al (2009) studied the features of soil stabilization with the replacement of lime with eggshell fillers. They have carried out experimental investigations so as to assess the betterment of attaining soil stabilization with the help of eggshell powder instead of lime.

Oluwatuyi O.E. et al (2010) defined the peculiar conclusions over laboratory assessments towards lateritic soil that was treated with crushed eggshell powder and cement, both mixed in equal proportion, as a mixture for the construction of highways. These fillers were added to the soil ranging from 0%-8% over the soil weight. Subsequently, these mixtures were assessed with numerous experimentalinvestigations.

Barzesh et al. (2012) and Nayankson et al. (2013) has also found the positive effects of egg shell powder on properties of expansive soil.

Amit Tiwari (2014), "Experimental Study on Stabilization of Black Cotton Soil byFly Ash, Coconut Coir Fiber & Crushed Glass" Accordingly, 8% mixing of crushed glass powder with the overall soil weight offered increased stabilization and was potentially applicable in highway constructions.

3. METHODOLOGY

The Soils which exhibit a peculiar exchange of swell-shrink behavior due to moisture fluctuations are known as expansive soils. Expansive soils can cause serious problems on civil engineering structures because of their tendency to heave during wet season and shrink during dry season. Swelling of expansive soils cause grave problems and create damage to structures. Expansive soil is the worldwide problems that possess several problems to the civil engineers.Experimental setup of soil specimen material used, observations and test procedure followed are described below under respective heading. Following tests had been carried out on black cotton soil to determine the engineering properties. The MDD and OMC test was carried out on varying percentage of egg shell powder and glass powder. Optimum percentage of egg shell powder and glass powder was determined by the results obtained and the strength comparison was carried out by performing UCS test with the use of these wastes.

- Determination of moisture content.
- Grain size distribution by sieve analysis.
- Determination of specific gravity of soil by pycnometer.
- Determination of consistency limits (L.L., P.L, S.L.).
- Standard Proctor test
- Conducting unconfined compressive strength of soil.

A. Materials Used

Soil : Soil sample used in the project work for the experimental purpose is excavated from a depth of 1.5 m below the ground level from Pote College Campus, Kathora ,Amravati, the soil sample collected is black in color.

Egg shell powder: Chicken eggshell is a waste material from domestic sources such as poultries, hatcheries, homes and fast food restaurants. Eggshells were spread on the ground and air dried for 2 days to facilitate easy milling. After air drying the eggshells were manually broken and milled into powdery forms which were collected in polythene bags. The eggshell powder was finally sieved through 425µ sieve. Eggshell powder contains 99.83% of CaO and remaining consists of Al2O3, SiO2, Cl, Cr2O3, MnO and CuO.

Figure 1: Egg Shell Powder

Glass Powder: Glass is an amorphous non-crystalline material which is typically brittle and optically transparent. Most of the readily available waste glass materials are soda-lime glass bottles, composed of about 75% silica plus, CaO and several additives. Glass degrades in a manner similar to

natural rock. As an inert material, it be used to increase the strength of black cotton soil. This material is added to soil in its powdered form for stabilization. Glass powder is an extremely fine powder made from ground glass. Glass was gotten from Coca Cola bottles and crushed because crushed glass is effectively used as an aggregate for sub- base. The glass powder was crushed till a size <0.075 mm was attained**.**

Figure 2: Glass Powder

4. RESULT AND DISCUSSION

The various engineering properties of expansive soil had been obtained by performing laboratory tests as per standard procedure given by Indian Standard and as discussed earlier. The observations and results obtained by performing the different tests to determine engineering properties of soil are as given below.

A. Determination of Water Content

Table 1 Observation of Water Content

S.No	Description	Determination No		
		1	2	3
1	Weight of empty container(w1) in g	20.12	20.08	20
2	Weight of container + Wetsoil (w2) in g	44.12	44.11	46.10
3	Weight of container + Drysoil (w3) in g	41.18	41.16	43.01
	Calculations			
1	Weight of water = w2-w3	2.94	2.95	3.09
2	Weight of solid =w3-w1	21.06	21.08	23.01
3	Water Content =(w2w3)/(w3-w1)x100	13.96	13.99	13.43
	Average Value	**13.79%**		

B. Grain Size Analysis Test

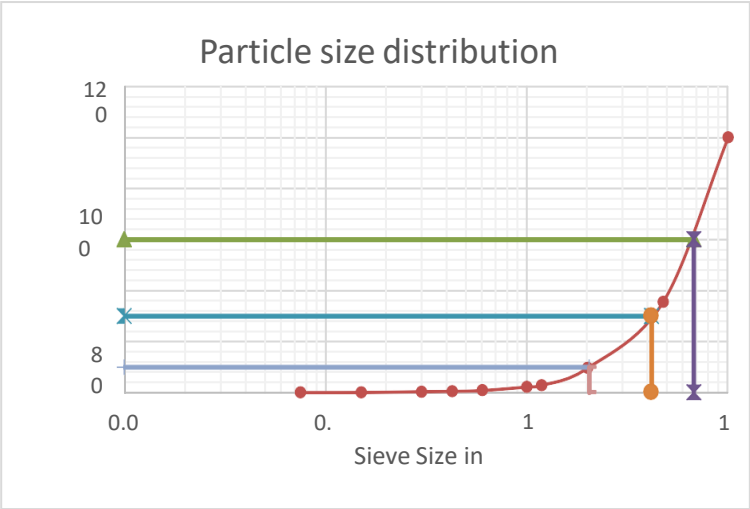

Figure 3 Relationship between particle size and % finer

C. Determination of Specific Gravity Table

Table 2 Observation Table of Specific Gravity

Particulars	Sample no. 1	Sample no. 2	Sample no. 3
Weight of pycnometer(w1)	452 gm	452 gm	452 gm
Weight of pycnometer +oven dried soil(w2)	848 gm	795.5 gm	832.5
Weight of pycnometer +oven dried soil +water(w3)	1452 gm	1440.5 gm	1447 gm
Weight of pycnometer +full of water(w4)	1223 gm	1223 gm	1223 gm
Specific gravity of soil	2.37	2.72	2.43
Average specific gravity	2.50		

D. Determination of Liquid Limit

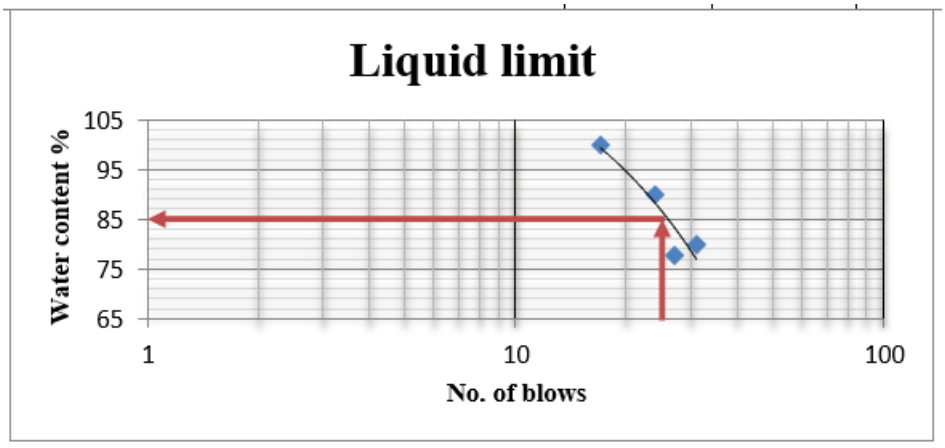

Figure 4 Relationship between No of Blows and Water Content

The liquid limit of the sample was found to be 85.0%.

E. Standard Proctor Test

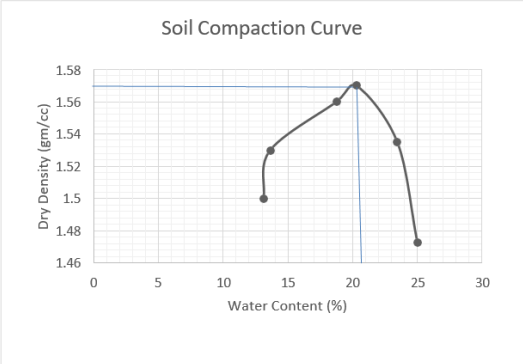

Figure 5 Relationship between moisture content and dry density

F. Unconfined Compressive Strength

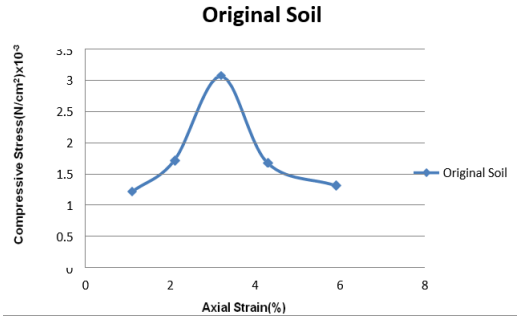

Figure 6: **Unconfined Compressive Strength of Soil**

The Compressive Stress of original soil is found to be 3.07 x10^{-3} N/cm^2.

G. Discussion

Effect of Egg Shell Powder

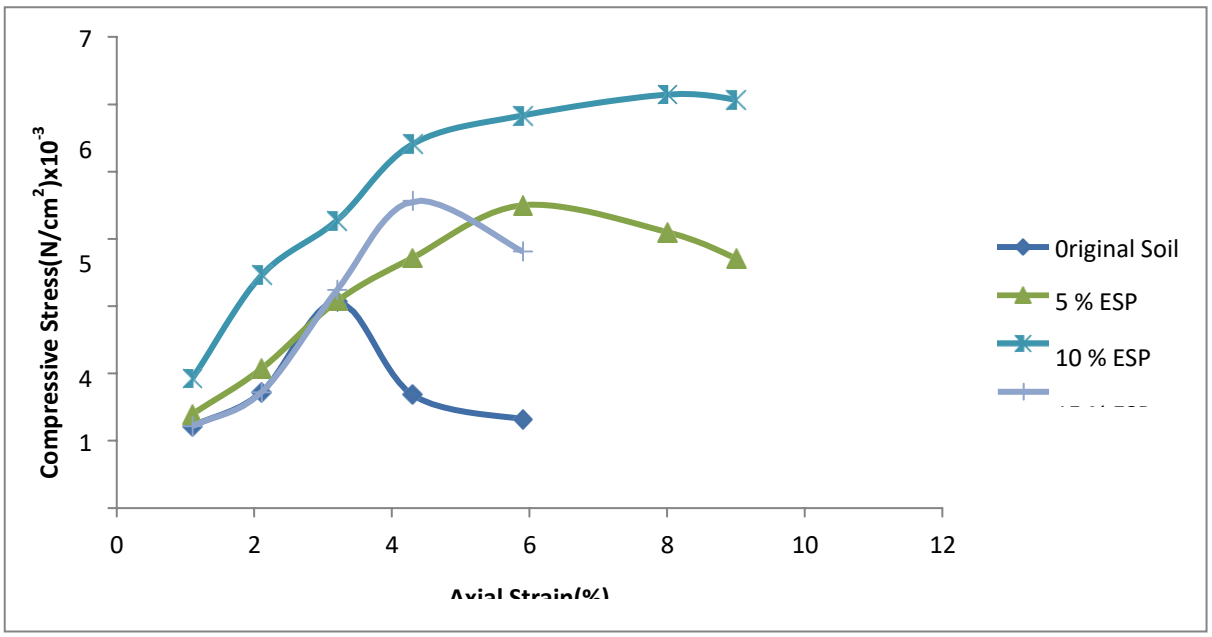

Figure 7 Effect of Egg Shell Powder on Unconfined Compressive Strength of soil

From the above graph we saw that by increasing the percentage of egg shell powder upto 10% there is increase in Unconfined compressive stress .After that by increasing the percentage of egg shell powder at 15% the unconfined compressive stress decreases**.**

Effect of Glass Powder

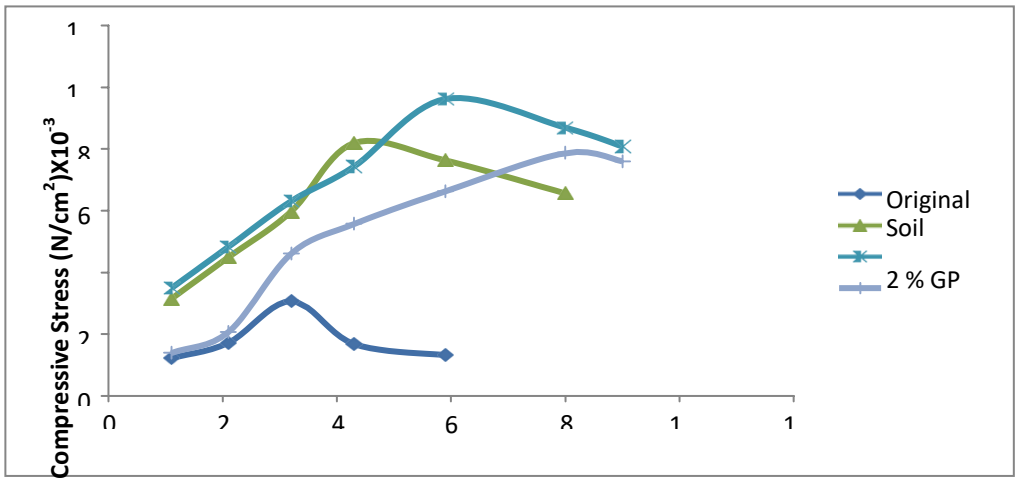

Figure 8 Effect of Glass Powder On Unconfined Compressive Strength of Soil

From the above graph we saw that by increasing the percentage of glass powder upto 4% there is increase in Unconfined compressive stress .After that by increasing the percentage of egg shell powder at 6% the unconfined compressive stress decreases. So that Optimum Percentage of Egg shell powder is 10 % and Optimum Percentage of Glass powder is 4 %. At this Percentage the Unconfined Compressive Strength increases than otherpercentages At this optimum Percentages of Egg Shell Powder and Glass Powder again study is carried out to determine its effects on unconfined strength of black cotton soil

Effect of Egg Shell Powder and Glass Powder

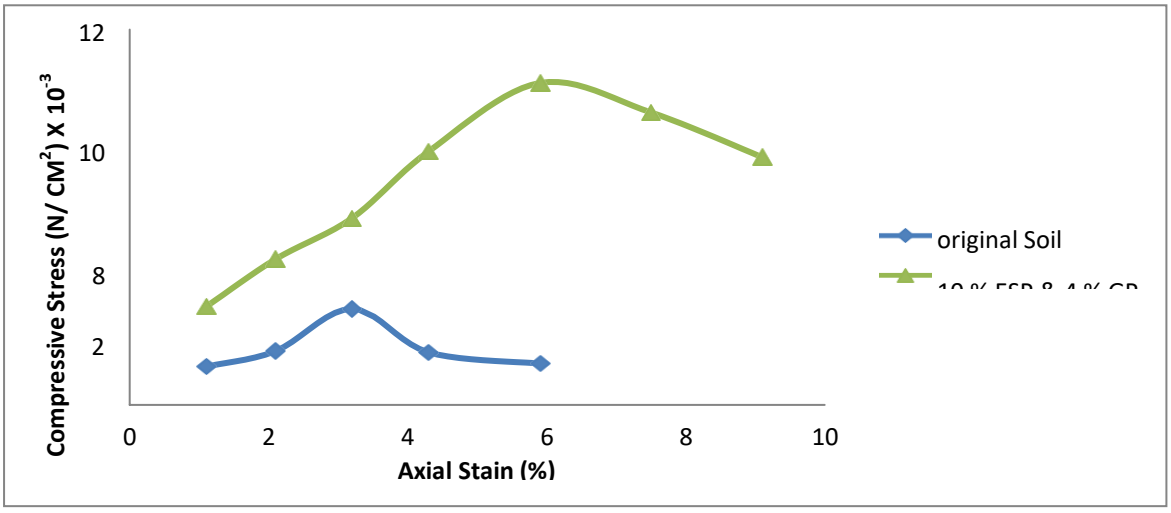

Figure 9 Effect of Egg Shell Powder and Glass Powder on Unconfined CompressiveStrength of soil

From the above graph we saw that by the combination of Optimum percentage **of** Egg ShellPowder and Glass Powder there is also increase in Unconfined compressive stress of black cotton soil which is more than original soil and optimum percentage of egg shell and glass powder also.

5. CONCLUSION

The Study was conducted to investigate the effect of Egg Shell Powder and Glass Powder on Unconfined Compressive Strength of black cotton soil. Based on laboratory Study, the following conclusion can be drawn:

From the investigation carried out, the following conclusions are made:

0. Egg shell powder was found to be a good material to stabilize the black cotton soil. The use of egg shell powder in soil stabilization will reduce the disposal problems of egg shell as well as make the stabilization process economical and sustainable.

1. Glass powder was also found to be a good material to stabilize the black cotton soil. From the above report we can conclude that the glass powder gives more dominant results than egg shell powder at minimum percentage.

2. From both the materials used the unconfined compressive strength increases as that oforiginal soil.

6. REFERENCES

1. Jain AK, Jha AK, Shivanshi. Geotechnical behavior and micro-analyses of expansive soil amended with marble dust. Soils and Foundations. 2020;60(4):737–751. Available from: https://dx.doi.org/10.1016/j.sandf.2020.02.013.
2. Kumar CR, Gadakari RS, Vani G, Mini KM. Stabilization of black cotton soil and loam soil using reclaimed asphalt pavement and waste crushed glass. Materials Today: Proceedings. 2020; 24:379–387. Available from: https://dx.doi.org/10.1016/j.matpr.2020.04.289.
3. Srinadh D, Praneeth P, Reddy D, Chamberlin K, Kumar NS. Stabilization of Black Cotton Soil using Lime and G.G.B.S (Ground Granulated Blast Furnace Slag) As an Admixtures. International Journal of Innovative Technology and Exploring Engineering (IJITEE). 2019;9(2):2133–2136.
4. Atahu MK, Saathoff F, Gebissa A. Mechanical behaviors of expansive soil treated with coffee husk ash. Journal of Rock Mechanics and Geotechnical Engineering. 2018. Available from: https://doi.org/10.1016/j.jrmge.2018.11.004.
5. Surjandari NS, Dananjaya RH, S EJ. The effect of egg shell powder on the compression strength of fine-grained soil. MATEC Web of Conferences. 2018;195. Available from: https://dx.doi.org/10.1051/matecconf/201819503011.
6. Shekhawat P, Sharma G, Singh RM. Potential Application of Heat Cured Eggshell Powder and Fly Ash-Based Geopolymer in Pavement Construction. International Journal of Geosynthetics and Ground Engineering. 2020;6(2). Available from: https://dx.doi.org/10.1007/s40891-020-00213-2.
7. Atsuko, S., Satoru, K.A., Hata, T., S., Hayashi, T., "Possibility for Solidification of Peaty Soil by Using Microbes", International Journal of GEOMATE, Vol. 10, Issue 22, pp.2071-2076 Geotec, Const. Mat and Env. ISSN:2186-2990, 2016.

8. Ayeni, P., Babatunde, O.A., and Dahunsi B.O., "Partial Replacement of Granites with Glass Chips (Glassorazzo) in Concrete Tiles." International Journal of Scientific & Research Volume 10, Issue 1, January-2019. ISSN 2229-5518, 2019.
9. Babatunde, O.A., Sani, J.E., and Sambo, A.H., "Reliability Estimation of Strength Properties in Black Cotton Soils Stablized with Glass Powder", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 8, Issue 3, ISSN: 2319-8753 2019.
10. Bordoloi, S., Garg A., Sekharan, S "A Review of Physio-Biochemical Properties of Natural Fibers and Their Application in Soil Reinforcement", Advances in Civil Engineering Materials, Vol.6, No.1, pp.323-359. ISSN:2379-1357, 2017.
11. Gaw, B., Zamora, S., Albano, L.D., Tao, M., "Soil Reinforcement with Natural Fibers for Low-Income Housing Communities." Bachelor's Thesis, Worcester Polytechinic Institute, Worcester, Ma, Usa, 2011. 6. Ghosha, S.K., Bhattacharyya, R., Mondal, M.M., "Potential Applications of Open Weave Jute Geotextile (Soil Saver) In Meeting Geotechnical Difficulties, Procedia Engineering, Vol 200, pp200-205,2017.
12. Hamidu, H. I., Sani J. E., Bello A. O., and Yisa G. L. "Reliability Estimate of Unconfined Compressive Strength of Black Cotton Soil stabilized with Bagasse Ash and Cement Kiln Dust." International Journal of Scientific & Engineering Research, Volume 6, Issue 8, Pp. 1507 – 1521. ISSN 2229-5518, 2015.
13. Sani, J. E., Yohanna, P. and Chukwujama , I. A. Effect of rice husk ash admixed with treated sisal fibre on properties of lateritic soil as a road construction material, Journal of King Saud University – Engineering Sciences, https://doi.org/10.1016/j.jksues.2018.11.001 Pp. 1- 8.,2018.
14. Subash, K., Sukesh, S.,Sreerag, R., Dilna, S, V., Deeraj, A.D., Jino, J., "Stabilization of Black Cotton Soil using Glass and Plastic Granules", International Journal of Engineering Research & Technology, Vol.5, Issue04, ISSN: 2278-0181, 2016.
15. Swaidani A., Hamoud, I., Meziab, A., "Effect of Adding Natural Pozzolana on Geotechnical Properties of Lime-Stabilized Clayey Soil", Journal of Rock Mechanics and Geotechnical Engineering. Vol 8, Issue 5, pp714-725, 2016.
16. Yohanna, P., Oluremi, J.R., Eberemu, A.O., Osinubi, K.J. and Sani, J.E. Reliability Assessment of Bearing Capacity of Cement–Iron Ore Tailing Blend Black Cotton Soil for Strip Foundations. GeotechGeolEng Volume 37, Issue 2, pp 915–929. https://doi.org/10.1007/s10706-018- 0660-2, 2019.
17. Yisa, G. L. and Sani, J. E. "Reliability Estimate of Strength Characteristic of Iron Ore Tailing Stabilized Lateritic Soil for Road Pavement Subbase Materials." Electronic Journal of Engineering,19:4177-4192, Bund.S, 2014.
18. Zakikhani, P. Zahari, R. Sultan, M.T.H. Majid, D.L Extraction and Preparation of Bamboo Fiber-Reinforced Composites., 2005.
19. Amu, O. O., A. B. Fajobi, and B. O. Oke. "Effect of eggshell powder on the stabilizing potential of lime on an expansive clay soil." Journal of Applied Sciences5.8 (2005): 1474-1478.
20. Bowles, Joseph E. "Physical and geotechnical properties of soils." (1979).

21. Petry, Thomas M., and Dallas N. Little. "Review of stabilization of clays and expansive soils in pavements and lightly loaded structures—history, practice, and future." Journal of Materials in Civil Engineering 14.6 (2002): 447-460.
22. Barazesh, A., Saba, H., Gharib, M. and Rad, M.Y. (2012) "Laboratory Investigation of the Effect of Eggshell Powder on Plasticity Index in Clay and Expansive Soils," European Journal of Experimental Biology, 2 (6), 2378-2384. 10. Basha, E.A. Hashim, R. and Muntohar, A.S. (2003) 'Effect of the Cement- Rice Husk Ash on the Plasticity and Compaction of soil," Electronic Journal of Geotechnical Engineering, 8 (A).
23. Eberemu, A.O., Amadi, A.A. and Lawal, M. (2012) "The Geotechnical Properties of Black Cotton Soil Treated with Crushed Glass Cullet," Nigerian Journal of Technological Research, 7(2), 23-30.
24. IS: 2720 (Part 5) - 1985 Indian Standard Code of practice for Determination of LiquidLimit.
25. IS: 2720 (Part 6) - 1972 Indian Standard Code of practice for Determination of PlasticLimit.
26. IS: 2720 (Part 8) - 1983 Indian Standard Code of practice for Determination of Modified Proctor Compaction parameters.